

FINAL SUBMITTAL EXECUTIVE SUMMARY

FORT PICKETT

ENERGY ENGINEERING ANALYSIS PROGRAM

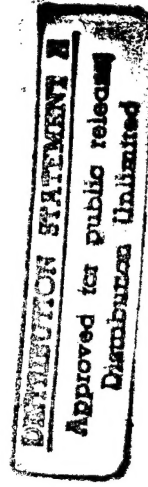
CONTRACT NO. DACA65-81-C-0021

for the NORFOLK DISTRICT
CORPS OF ENGINEERS

prepared by

MMM DESIGN
GROUP

A PROFESSIONAL CORPORATION
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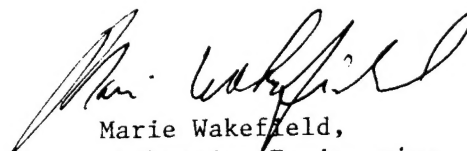


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FORT PICKETT

ENERGY ENGINEERING ANALYSIS PROGRAM

CONTRACT NO DACA65-81-C-0021

FOR THE
NORFOLK DISTRICT CORPS OF ENGINEERS

PREPARED BY

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MMM DESIGN GROUP

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IV EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 OBJECTIVE

This is a summary of an Energy Engineering Analysis, conducted to provide a Basewide Energy Savings Plan at Fort Pickett, Virginia. This Plan includes recommendations for energy conservations Projects to reduce the installation's present energy consumption, as well as a description of other energy-related factors which affect consumption. It is important to note that savings figures presented in this summary can only be realized after all Projects have been implemented. MMM Design Group has developed Projects that meet the funding requirements for the D.O.D.'s Energy Conservation Investment Program. Furthermore, the recommended Projects provide compliance with the Army Facilities Energy Plan. This summary presents data relative to the following chronological period:

- A. 1975 Energy Consumption (baseline).
- B. 1985 Energy Use (projection).

1.2 METHODOLOGY

The Analysis methodology was based in part on an examination and study of a "sampling" of structures representative of all of the structures at Fort Pickett. These "sample" or "study" buildings were used to model "building use groups" which had similar architectural, mechanical, and electrical system characteristics, as well as similar functional uses. These characteristics are summarized in Figures 1, 2, and 3.

2. EXISTING ENERGY CONSUMPTION

Once these building group system characteristics were determined, they were input into the Corps of Engineers Building Loads Analysis and Systems Thermodynamics (BLAST) Program. Then, the BLAST Program parameters were manipulated in order to simulate 1975 conditions. See Building Group Energy Usage (Figure 4) for a description of energy sources, and energy use totals by building group. Finally, a total MBTU consumption record was prepared to model actual consumption between 1975 and 1980, adjusted for historic degree days, (Figures 5). These figures reflect a total consumption of 168,999 MBTU for the 1975 baseline, including energy use for on-base buildings, Reserve Centers and all other energy consuming systems (site utilities, site lighting, etc.).

Figures 6A through 6C illustrate the relative percentages of fuel types used during the 1980 fiscal year. Noteworthy is the fact that electricity and fuel oil make up the largest portions of the consumed energy mediums, comprising 47% and 44% respectively. The remaining fuel types include LP and natural gas at 8% and kerosene at 1%.

Figures 7A through 7C indicate the annual source energy consumed by each of the significant building groups used in the energy model, and compare this consumption with the building group area. Housing is the largest user, consuming 27% of total energy, administrative the second largest consumer on-base at 20%, and shops consume 15%. Recreation and dining facilities use 10% and 7% respectively. Utilities use approximately 4%. Off-base reserve centers are the second largest overall user at 20%.

3. ENERGY CONSERVATION MEASURES DEVELOPED

3.1 Introduction

The tool used for initial analysis of possible new energy conservation measures or options at Fort Pickett was a Preliminary Matrix (Figure 8). This matrix ranked each option by building use group, and established priorities for detailed study and project development of selected options.

The separately bound "Appendix" volume of this Energy Engineering Analysis provides documentation of the back-up material developed during the course of the work. The results of the programmed energy conservation Projects are included in the separately bound volume entitled "Project Documentation." A summary of all Projects, categorized by EEA study Increment, can be found in the EEA Project Summary (Figure 9): These projects are listed in order of their E over C Ratio.

3.2 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENTS (A) AND (B)

A total of nine (9) projects, Increments (A) and (B), qualified under ECIP criteria as programmable energy conservation projects for on-base facilities. Included are the installation of ceiling fans for atmospheric destratification as well as noncombustable insulation for domestic water heaters and building envelopes. Also qualifying for these Increments are the replacement of inefficient oil burners, boilers and light fixtures, and the installation of night setback thermostats and a basewide Energy Management Control System.

In addition several projects qualified for Increment (A) for off-post reserve centers. Included are the installation of thermostats for night setback, minimum occupancy heating and cooling units, weatherstripping, caulking and ceiling insulation.

3.3 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENT (G)

A total of five (5) Projects did not meet the necessary ECIP criteria, and therefore do not appear in the Project Documentation volume of this report. These projects were subsequently classified under Increment (G). Included under this increment are the installation of storm windows, weatherstripping and caulking, timer switches for toilet room lighting, domestic water heater controls, and wall insulation for CMU walls.

3.4 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENT (C)

Several options were analyzed for potential renewable energy projects (Increment C). Included in this part of the study is a solar domestic water heating system, an active solar application. Trombe wall adaptations are presented as a passive solar application. Additionally, biomass fuel potential at the Fort is evaluated. None of the options analyzed qualified for ECIP funding.

3.5 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENT (F)

Recommendations for modifications to system operation at Fort Pickett, which are within the funding authority and/or management control of the Facilities Engineer, fall into four broad categories.

- A. Replacement of "as-needed" system components with "state-of-the-art", high-efficiency components: Such components as electrical lamps, water system pump motors, and high-bay roll-up doors, are examples of opportunities to save energy by means of Facility Engineer selection and purchase procedures.
- B. Elimination of unnecessary energy consuming items: This proposal requires coordination with current and programmed building use. It involves the elimination of domestic hot water in Administration buildings, the reduction of window glazing where not required for natural light, ventilation or egress, and the reduction of lighting levels to minimum standards.
- C. Controls of energy systems: This suggestion includes miscellaneous installations of photocell and time clock controls for lighting, selective switching of lighting and domestic hot water circulating pump controls.
- D. Future Metering Plan: Provided for the future monitoring of electricity consumption, this plan determines the high energy use buildings on base and suggests locations for future electrical meters.

The above recommendations are discussed in more detail within the body of the Report Narrative.

4. ENERGY AND COST SAVINGS

The annual energy savings by proposed Project are given in Figures 9, along with the payback period, in years. This payback is based on the implementation of all Projects by fiscal year 1985, and uses fuel types related to each respective project. Fuel cost escalation is given from 1980 to 1985 in Figure 10, entitled "Energy Cost Projection."

For projected energy consumption and total energy savings to be realized, savings from inter-related or interdependent projects must be coordinated. Thus, the total energy savings, as shown in the Energy Projection Summary (Figure 11), is based on the assumption that all projects will be implemented by a given fiscal year (1985).

5. ENERGY PLAN

A Fort Pickett Basewide Energy Savings Plan, the ultimate result of this Energy Engineering Analysis, includes energy use input from the following:

- A. Past Energy Conservation Projects.
- B. Energy Conservation Projects Under Contract.
- C. Operational and Maintenance Projects.
- D. Demolition and Shutdown.
- E. New Construction Projects.
- F. Recommended Energy Conservation Projects.

A summary of the above energy use factors is given in Figure 11, the Energy Projection Summary, with the exception of Increment C and Increment G energy savings, as well as savings from several Increment F projects which could not be projected. (See Figure 9).

As a result of total implementation of the Fort Pickett Basewide Energy Savings Plan, energy usage per square foot of building area will be reduced by over 20%. This reduction of energy usage per square foot shall equate approximately to the following:

- A. FY 1975 BTU/square foot = 72,000.
- B. FY 1985 BTU/square foot = 57,000.

See Section 3 of the Appendix for Back-up calculations of these figures.

Past and ongoing energy conservation projects, along with those projects recommended by this Energy Engineering Analysis, account for a 31% reduction in FY 1975 energy consumption. However, the sum of new construction and decreased winterization results in a 18% increase in energy consumption. This increase severely reduces the impact of the savings achieved by energy conservation projects. The final result of the savings plan, as seen in Figure 11, is an overall 13.0% decrease in annual energy consumption by FY 1985.

FORT PICKETT BUILDING USE GROUPS SUMMARY

| BUILDING USE GROUP | SUB-GROUP NO. | STUDY BUILDING NO. | WALL CODE | ROOF CODE | EN. SYS. CODE | TOTAL SUB-GROUP SQUARE FEET | TOTAL USE GROUP SQUARE FEET |
|--|---------------|---------------------|-----------|-----------|---------------|-----------------------------|-----------------------------|
| ADMINISTRATION | A-1 | 471/472/473 | WD | PS | AB | 274,062 | 284,182 |
| | A-2 | NONE | VARIES | VARIES | B | 10,120 | |
| QUARTERS | B-1 | 467/2442 | WD | PS | AB | 1,076,346 | 1,095,776 |
| | B-2 | NONE | VARIES | VARIES | B | 19,430 | |
| SHOPS | C-1 | 318/564 | WD | PS | AB | 280,556 | 293,174 |
| | C-2 | NONE | VARIES | VARIES | B | 12,618 | |
| DINING | D-1 | 467/2101/2440 | WD | PS | AB | 217,952 | 217,952 |
| WAREHOUSE | E-1 | NONE | VARIES | VARIES | B | 465,277 | 465,277 |
| RECREATION | F-1 | 1613 | WD | PS | AB | 166,506 | 231,760 |
| | F-2 | NONE | VARIES | VARIES | B | 65,254 | |
| NONENERGIZED | G-1 | NONE | VARIES | VARIES | 0 | 42,174 | 42,174 |
| TOTAL BUILDING AREA - ON BASE (FY1980) | | | | | | | 2,630,295 |
| RESERVE CENTERS | R-1 | MICHELLI/HALL/MONT. | MAS | BU | AB | 93,632 | 251,379 |
| | R-2 | DUBLIN | MAS | BU | AB | 77,091 | |
| | R-3 | CHARLOTTESVILLE | MAS | BU | AB | 34,925 | |
| | R-4 | COVINGTON | MAS | BU | AB | 45,731 | |
| TOTAL BUILDING ARE - OFF BASE RESERVE CENTERS (FY 1980) | | | | | | | 251,379 |
| WALL CONSTRUCTION CODE: WD - WOOD FRAME OR WOOD FRAME WITH BRICK VENEER. ENERGIZED SYSTEMS CODE: AB - HEATING AND NON HEATING SYS. MAS - MASONRY BLOCK OR BRICK. B - NON-HEATING SYSTEMS. ROOF CONSTRUCTION CODE: PS - PITCHED SHINGLE OVER WOOD DECK. 0 - NO ENERGIZED SYSTEMS. BU - BUILT UP ROOF OVER WOOD DECK OR METAL DECK. | | | | | | | |

FIGURE 1

FORT PICKETT CONSTRUCTION CHARACTERISTICS OF TYPICAL BUILDINGS

| SUB GROUP NUMBER | BUILD. NUMBER | BUILDING USE | NO. OF FLOORS | BUILD. AREA (FT. ²) | ROOF TYPE AREA (FT. ²) | U VALUE | WALL TYPE AREA (FT. ²) | U VALUE | DOOR TYPE AREA (FT. ²) | U VALUE | FLOOR TYPE PERIM. (FT.) | U VALUE | WINDOW TYPE AREA (FT. ²) | U VALUE |
|------------------------|------------------|-------------------------------|------------------|---------------------------------------|---|------------|---|------------|---|------------|----------------------------------|------------|---|------------|
| A-2 | 471 | MILITARY POLICE HDQTRS. | 1 | 6606 | ASPH. SHGL. (7590) | 0.04 | METAL SDG. (3392) | 0.16 | WOOD (200) | 0.60 | CRAWL (524) | 0.27 | STORM (468) | 0.99 |
| A-1 | 472 | POST HDQTRS. | 1 | 6606 | ASPH. SHGL. (7590) | 0.04 | METAL SDG. (3392) | 0.16 | WOOD (140) | 0.60 | CRAWL (524) | 0.27 | STORM (564) | 0.99 |
| A-1 | 473 | POST HDQTRS. | 1 | 6606 | ASPH. SHGL. (7590) | 0.04 | METAL SDG. (3392) | 0.16 | WOOD (140) | 0.60 | CRAWL (524) | 0.27 | STORM (564) | 0.99 |
| B-1/ B-2 | 2442 | BARRACKS | 2 | 5310 | ASPH. SHGL. (2400) | 0.36 | VINYL SDG. (2963) | 0.24 | WOOD (76) | 0.60 | EXPOSED (220) | 0.62 | SGL.PN. WD.FRM. (642) | 0.99 |
| B-1 | 467 | BARRACKS | 1 | 5681 | ASPH. SHGL. (5681) | 0.05 | BRICK WD.SDG. (3372) | 0.17 | METAL (168) | 0.60 | SLAB (7889) | - | THERMAL (448) | 0.99 |
| C-1 | 318 | MOTOR REPAIR SHOP | 1 | 22770 | BUILT UP (23431) | 0.05 | METAL SDG. (19699) | 0.21 | WOOD (432) | 0.60 | SLAB (632) | - | STORM (2541) | 0.99 |
| C-1 | 564 | MOTOR REPAIR SHOP | 1 | 18270 | BUILT UP (18800) | 0.05 | METAL SDG. (15806) | 0.21 | WOOD (323) | NEG. | SLAB (632) | - | STORM (2160) | 0.99 |
| D-1 | 467 | MESS HALL | 1 | 6275 | ASPH.S BLT-UP (6440) | 0.03 | BRICK WD.SDG. (3827) | 0.10 | METAL (350) | 0.60 | SLAB (382) | - | THERMAL (236) | 0.99 |
| D-1 | 2101 | NCO CLUB | 2 | 20740 | ASPH. SHGL. (2.342) | 0.07 | METAL SDG. (6740) | 0.16 | METAL (336) | 0.60 | CRAWL (1000) | 0.28 | STORM (924) | 0.99 |
| D-1 | 2440 | MESS | 1 | 2950 | ASPH. SHGL. (2408) | 0.25 | VINYL SDG. (1767) | 0.27 | WOOD (108) | 0.60 | EXPOSED (238) | 0.53 | SGL.PN. WD.FRM. (300) | 0.99 |
| F-1 | 1613 | SPORTS ARENA | 1 | 24368 | DOME ENTRY (20272) | 0.06 | METAL SDG. (5002) | 0.16 | WOOD (485) | 0.65 | SLAB (838) | - | SGL. GLZ. (2033) | 1.10 |

■ - BLDG. 467 CONSISTS OF A 3-BLDG. COMPLEX, 2-IDENTICAL BARRACKS AND 1-MESS HALL

■ - WEIGHTED AVERAGE

FIGURE 2

FORT PICKETT CONSTRUCTION CHARACTERISTICS OF TYPICAL BUILDINGS

| SUB GROUP NUMBER | BUILD. NUMBER | BUILDING USE | NO. OF FLOORS | BUILD. AREA (FT.) | ROOF TYPE AREA (FT.) | U VALUE | WALL TYPE AREA (FT.) | U VALUE | DOOR TYPE AREA (FT.) | U VALUE | FLOOR TYPE PERIM. (FT.) | U VALUE | WINDOW TYPE AREA (FT.) | U VALUE |
|------------------------|----------------------|-----------------------------------|------------------|--------------------------|--------------------------------|------------|--------------------------------|------------|--------------------------------|------------|-----------------------------------|------------|----------------------------------|------------|
| F-2 | 2442 | BARRACKS | 2 | 5310 | ASPH. SHGL. (2400) | 0.36 | VINYL SDG. (2963) | 0.24 | WOOD (76) | 0.60 | EXPOSED (220) | 0.62 | SGL.PN. WD.FRM. (642) | 0.99 |
| R-1 | SALEM | HALL RESERVE CENTER | 2 | 25628 | BUILT UP (15132) | 0.09 | BRICK (14030) | 0.32 | METAL (424) | 0.60 | SLAB (750) | - | SGL.GLZ 50% ST. (2272) | 1.00 |
| R-1 | SHERWD. | MICHELLI RESERVE CENTER | 2 | 30727 | BUILT UP (20724) | 0.09 | BLOCK (15822) | 0.49 | METAL (382) | 0.60 | SLAB (1586) | - | SGL. GLZ. (2263) | 1.10 |
| R-1 | BELT | MONTEITH RESERVE CENTER | 2 | 23324 | BUILT UP (13840) | 0.09 | BRICK (11422) | 0.32 | METAL (424) | 0.60 | SLAB (750) | - | SGL. GLZ. (1877) | 1.10 |
| R-2 | DUBLIN | DUBLIN RESERVE CENTER | 1 | 21014 | BUILT UP (21400) | 0.09 | BRICK (10420) | 0.32 | METAL (375) | 0.60 | SLAB (710) | - | SGL. GLZ. (1672) | 1.10 |
| R-3 | CHARLOTT -ESVILLE | CHARLOTT -ESVILLE RES. CTR. | 1 | 19125 | BUILT UP (19375) | 0.09 | BRICK (984) | 0.32 | METAL (420) | 0.60 | SLAB (680) | - | SGL. GLZ. (1440) | 1.10 |
| R-4 | COVING -TON | COVINGTON RESERVE CENTER | 1 | 5982 | BUILT UP (6210) | 0.09 | BRICK (2832) | 0.32 | METAL (230) | 0.60 | SLAB (285) | - | SGL. GLZ. (630) | 1.10 |
| | | | | | | | | | | | | | | |
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■ - BLDG. 467 CONSISTS OF A 3-BLDG. COMPLEX, 2-IDENTICAL BARRACKS AND 1-MESS HALL

■ - WEIGHTED AVERAGE

FIGURE 2 (CONT.)

FORT PICKETT TYPICAL BUILDING SYSTEMS SUMMARY

| SUB GROUP NUMBER | BUILDING NUMBER | BUILDING USE | COOLING | | HEATING | | DOMESTIC HOT WATER | | NORMAL PEAK OCCUPANCY | OCCUPANCY SCHEDULE |
|------------------|------------------|-------------------------|-----------------|---------------------|-------------------|----------------------|--------------------|----------|-----------------------|--|
| | | | SYSTEM TYPE | CAPACITY (TONS) | SYSTEM TYPE | FUEL | SYSTEM TYPE | FUEL | | |
| A-2 | 471 | MILITARY POLICE HDQTRS. | NONE | - | CENTRAL STEAM | FUEL OIL | WATER HEATER | ELEC. | 25 | 24 HRS/DAY 365 DAYS/YR. |
| A-1 | 472 | POST HDQTRS. | NONE | - | CENTRAL STEAM | FUEL OIL | WATER HEATER | ELEC. | 20 | 8 HRS/DAY 5 DAYS/WK |
| A-1 | 473 | POST HDQTRS. | NONE | - | CENTRAL STEAM | FUEL OIL | WATER HEATER | ELEC. | 20 | 60 HRS/WK 6 MO/YR VARIES-6 MO/YR |
| B-1/ B-2 | 2442 | BARRACKS | NONE | - | FORCED AIR | OIL | 85 GAL. | OIL | 25 | 24 HR, 7 DAY/ WINTERIZED |
| B-1 | 467 [■] | BARRACKS | CENTRAL CHILLER | 29.0 | CENTRAL HOT WATER | FUEL OIL | WATER HEATER | FUEL OIL | 32 | 12 HRS/DAY 7 DAYS/WK |
| C-1 | 318 | MOTOR REPAIR SHOP | NONE | - | STEAM | FUEL OIL | WATER HEATER | ELEC. | 16 | 10 HRS/DAY-5 DAYS/WK 24 HRS/DAY 14 DAYS/YR |
| C-1 | 564 | MOTOR REPAIR SHOP | NONE | - | STEAM | FUEL OIL | WATER HEATER | ELEC. | 18 | 10 HRS/DAY 5 DAYS/WK |
| D-1 | 467 [■] | MESS HALL | CENTRAL CHILLER | 29.0 | CENTRAL HOT WATER | FUEL OIL | WATER HEATER | FUEL OIL | 50 [■] | 12 HRS/DAY 7 DAYS/WK |
| D-1 | 2101 | NCO CLUB | PACKAGE UNITS | (1)-10.0 (3)-7.5 | STEAM | FUEL OIL | WATER HEATER | ELEC. | 60 | 52 HRS/WK 52 WKS/YR |
| D-1 | 2440 | MESS | NONE | - | FORCED AIR | OIL | 500 GAL. | OIL | 150 | 0530-1630 1 WK/MO |
| F-1 | 1613 | SPORTS ARENA | NONE | - | STEAM | FUEL OIL/ LP IGN. | WATER HEATER | FUEL OIL | 40 | 70 HRS/WK 52 WKS/YR |

■ - BLDG. 467 CONSISTS OF A 3-BLDG. COMPLEX, 2-IDENTICAL BARRACKS AND 1-MESS HALL

■ ■ - WEIGHTED AVERAGE

FIGURE 3

FORT PICKETT TYPICAL BUILDING SYSTEMS SUMMARY

| SUB GROUP NUMBER | BUILDING NUMBER | BUILDING USE | COOLING | | HEATING | | DOMESTIC HOT WATER | | NORMAL PEAK OCCUPANCY | OCCUPANCY SCHEDULE |
|------------------|------------------|----------------------------|--------------|-----------------|--------------|----------|-----------------------|----------|-----------------------|--|
| | | | SYSTEM TYPE | CAPACITY (TONS) | SYSTEM TYPE | FUEL | SYSTEM TYPE | FUEL | | |
| F-2 | 2442 | RECREATION | NONE | - | NONE | - | 85 GAL. | OIL | 10 | 1000-2000 WINTERIZED |
| R-1 | SALEM | HALL RESERVE CENTER | WINDOW UNITS | 10,000 BTUH | HOT WATER | NAT. GAS | WATER HEATER SMR ONLY | NAT. GAS | 20 300 | 8 HRS/DAY-5 DAYS/WK 10 HRS/DAY 2 DAYS/WK |
| R-1 | SHERWOOD | MICHELLI RESERVE CENTER | WINDOW UNITS | 10,000 BTUH | STEAM | FUEL OIL | WATER HEATER SMR ONLY | NAT. GAS | 16 300 | 8 HRS/DAY-5 DAYS/WK 10 HRS/DAY 2 DAYS/WK |
| R-1 | BELT | MONELLI RESERVE CENTER | WINDOW UNITS | 10,000 BTUH | STEAM | FUEL OIL | WATER HEATER SMR ONLY | ELEC. | 18 350 | 8 HRS/DAY-5 DAYS/WK 10 HRS/DAY 2 DAYS/WK |
| R-2 | DUBLIN | DUBLIN RESERVE CENTER | CENTRAL DX | (1)-32 | HOT WATER | NAT. GAS | 85 GAL. | OIL | 3 150 | 8 HRS/DAY-5 DAYS/WK 10 HRS/DAY-2 DAYS/WK 2 WEEKENDS/MO |
| R-3 | CHARLOTT-ESVILLE | CHARLOTT-ESVILLE RES. CTR. | CENTRAL DX | (1)-2 (1)-14 | UNIT HEATERS | NAT. GAS | 85 GAL. | NAT. GAS | 2 100 | 8 HRS/DAY-5 DAYS/WK 10 HRS/DAY-2 DAYS/WK 1 WEEKEND/MO |
| R-4 | COVINGTON | COVINGTON RESERVE CENTER | WINDOW UNITS | 10,000 BTUH | FORCED AIR | NAT. GAS | 85 GAL. | NAT. GAS | 2 200 | 8 HRS/DAY-5 DAYS/WK 10 HRS/DAY-2 DAYS/WK 1 WEEKEND/MO |
| | | | | | | | | | | |
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■ - BLDG. 467 CONSISTS OF A 3-BLDG. COMPLEX, 2-IDENTICAL BARRACKS AND 1-MESS HALL

■ ■ - WEIGHTED AVERAGE

BUILDING GROUP ENERGY USAGE

FORT PICKETT - 1975 - BASE YEAR

| SUB-GROUP | STUDY BUILDING | Y/W | TOTAL GROUP SQ.-FT. | STUDY BUILDING GROUP AVERAGE BTU/FT ² -YR. | | | TOTAL BUILDING GROUP AVERAGE MBTU/YR. | | |
|--|----------------|-----|---------------------|--|---------|---------|--|--------|---------|
| | | | | ELECTRIC | FUEL | TOTAL | ELECTRIC | FUEL | TOTAL |
| A-1 | 471 | Y | 127,110 | 70,608 | 119,549 | 190,157 | 8,975 | 15,196 | 24,171 |
| | | W | 146,542 | 40,473 | 11,686 | 52,159 | 5,931 | 1,712 | 7,643 |
| A-2 | 471 | W | 8,552 | 40,473 | 11,686 | 52,159 | 346 | 100 | 446 |
| B-1 | 2442 467.B | Y | 65,707 | 62,000 | 116,925 | 178,925 | 4,074 | 7,683 | 11,757 |
| | 2442 (ONLY) | W | 1,009,312 | 19,790 | 19,396 | 39,186 | 19,974 | 19,577 | 39,551 |
| B-2 | 2442 | W | 19,430 | 19,790 | 19,396 | 39,186 | 385 | 377 | 762 |
| C-1 | 318 564 | Y | 168,438 | 48,485 | 102,095 | 150,580 | 8,167 | 17,197 | 25,364 |
| | | W | 114,535 | 18,370 | 6,012 | 24,382 | 2,104 | 689 | 2,793 |
| D-1 | 2440 | Y | 20,740 | 35,485 | 139,742 | 175,227 | 736 | 2,898 | 3,634 |
| | | W | 190,937 | 14,600 | 40,625 | 55,225 | 2,788 | 7,757 | 10,545 |
| F-1 | 1613 | Y | 24,368 | 193,969 | 147,065 | 341,034 | 4,727 | 3,584 | 8,311 |
| | | W | 142,138 | 49,093 | 8,462 | 57,555 | 6,878 | 1,203 | 8,181 |
| F-2 | 2442 | W | 65,254 | 19,790 | 19,396 | 39,186 | 1,291 | 1,266 | 2,557 |
| Y-DENOTES YEAR ROUND BUILDING USE W-DENOTES WINTERIZED BUILDING | | | | SITE UTILITIES AND LIGHTING - | | | 7,751 | - | 7,751 |
| | | | | BASEWIDE CALCULATED - | | | 74,227 | 79,238 | 153,468 |
| | | | | BASEWIDE HISTORICAL - | | | 54,921 | 79,516 | 134,437 |

BUILDING GROUP ENERGY USAGE

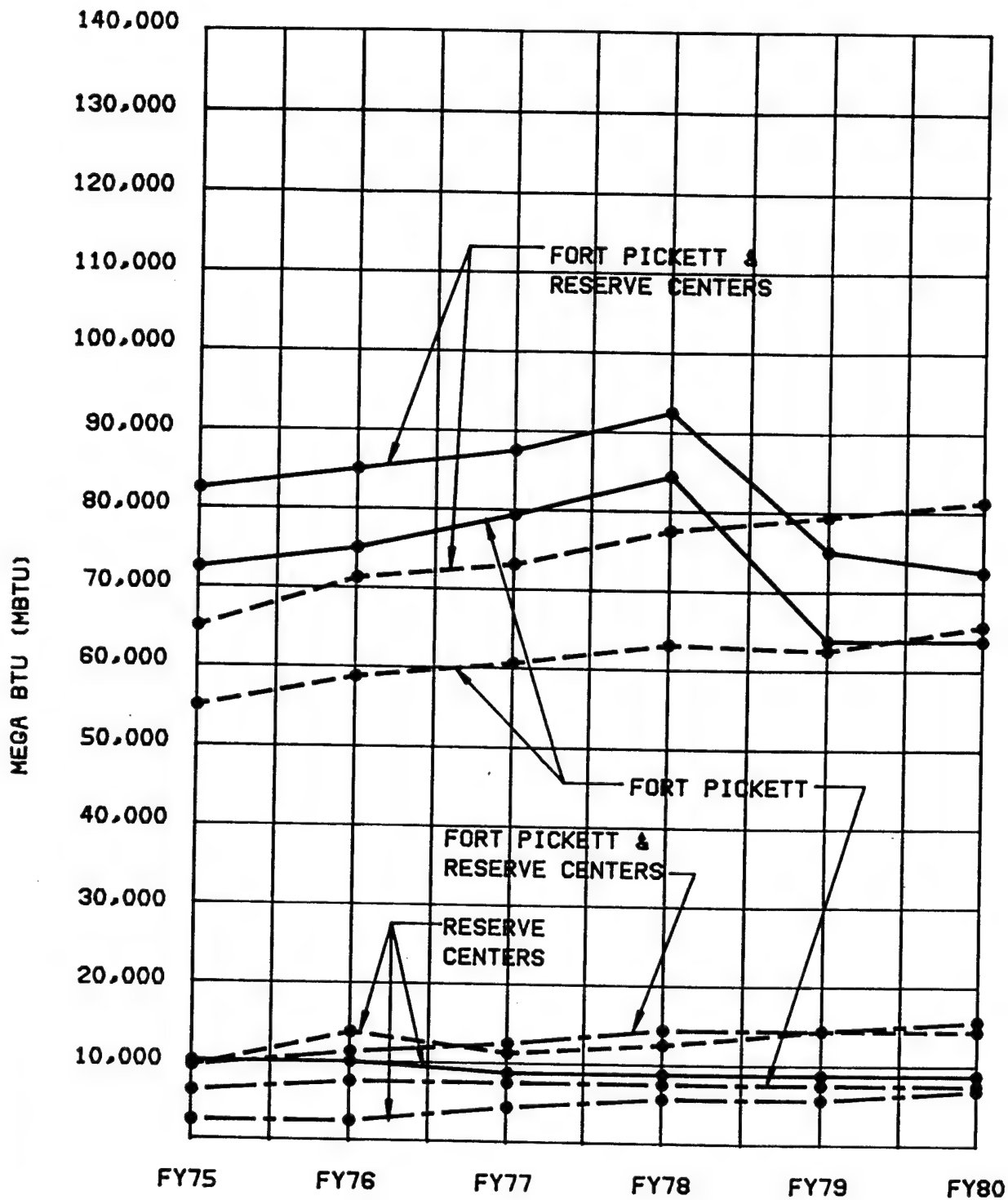
RESERVE CENTERS - 1975 - BASE YEAR

| SUB-GROUP | STUDY BUILDING | Y/W | TOTAL GROUP SQ.-FT. | STUDY BUILDING GROUP AVERAGE BTU/FT ² -YR. | | | TOTAL BUILDING GROUP AVERAGE MBTU/YR. | | |
|--|------------------------|-----|---------------------|---|---------|---------|---------------------------------------|---------|---------|
| | | | | ELECTRIC | FUEL | TOTAL | ELECTRIC | FUEL | TOTAL |
| R-1 | HALL MONTEITH MICHELLI | Y | 93,632 | 62,474 | 116,171 | 178,645 | 5,850 | 10,877 | 16,727 |
| | | - | - | - | - | - | - | - | - |
| R-2 | DUBLIN | Y | 77,091 | 99,522 | 75,591 | 175,113 | 7,672 | 5,827 | 13,499 |
| R-3 | CHARLOTT-ESVILLE | Y | 34,925 | 56,946 | 56,784 | 113,730 | 1,989 | 1,983 | 3,972 |
| R-4 | COVINGTON | Y | 45,731 | 44,018 | 75,764 | 119,782 | 2,013 | 3,465 | 5,478 |
| | | | | | | | | | |
| RESERVE CENTER CALCULATED ENERGY CONSUMPTION - | | | | | | | 17,524 | 22,152 | 39,676 |
| RESERVE CENTER HISTORICAL ENERGY CONSUMPTION - | | | | | | | 16,743 | 17,769 | 34,512 |
| | | | | | | | | | |
| GRAND TOTAL CALCULATED ENERGY CONSUMPTION - | | | | | | | 91,751 | 101,391 | 193,142 |
| GRAND TOTAL HISTORICAL ENERGY CONSUMPTION - | | | | | | | 71,664 | 97,285 | 168,949 |

NOTE: CALCULATED CONSUMPTION DATA IS FROM BLAST ANALYSIS.
HISTORICAL CONSUMPTION DATA IS FROM FORT PICKETT ENERGY CONSUMPTION RECORDS.

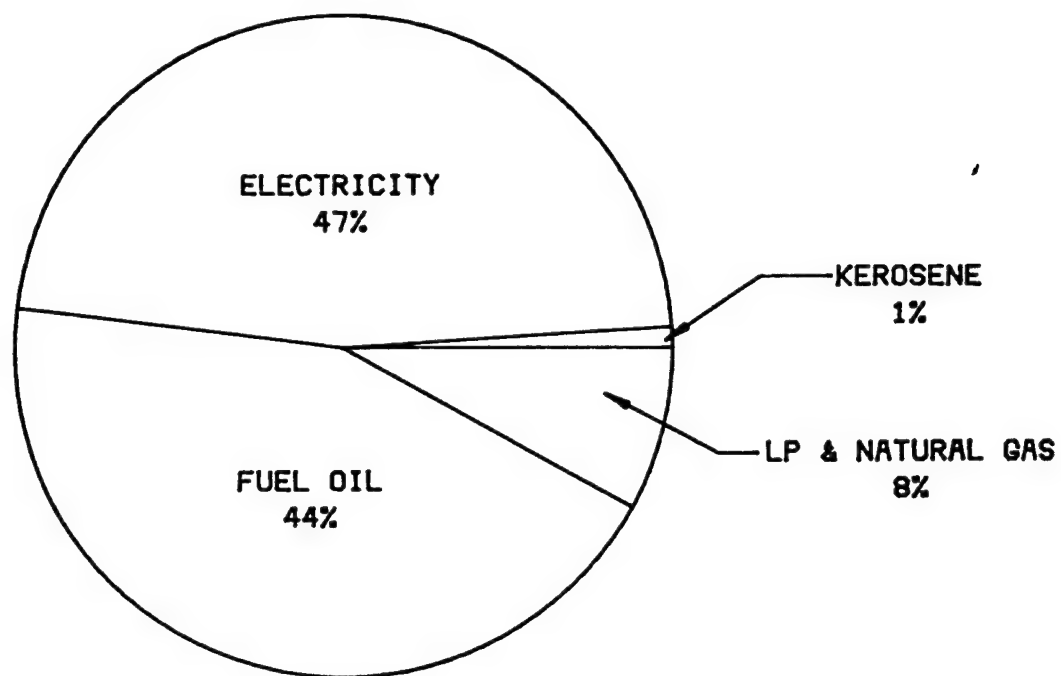
Y-DENOTES YEAR ROUND BUILDING USE
W-DENOTES WINTERIZED BUILDING

FIGURE 4 (CONT.)



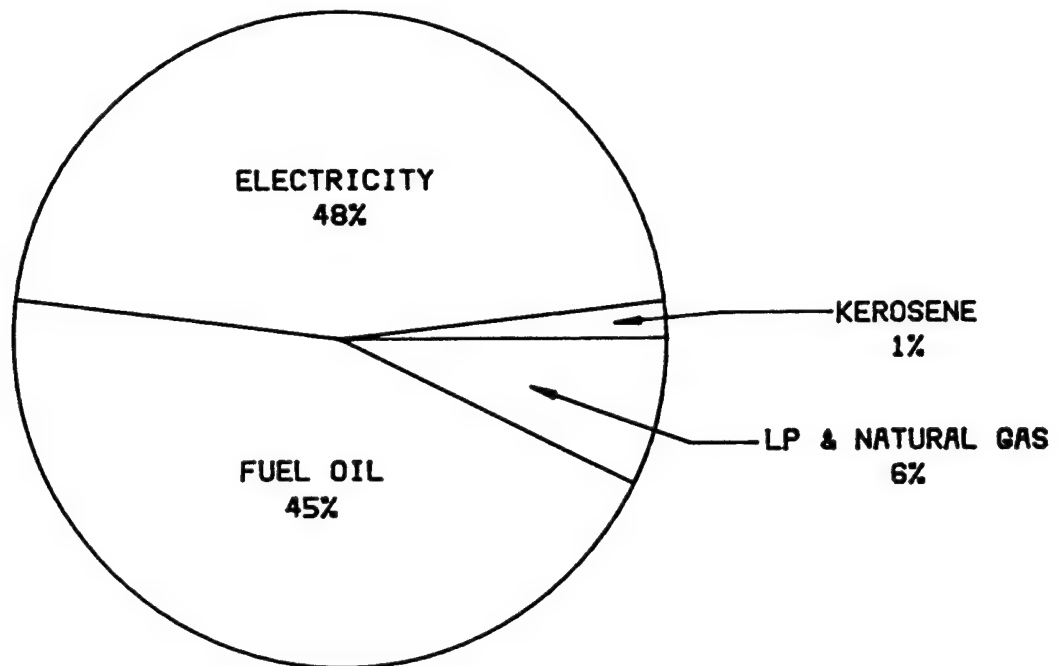
TOTAL ENERGY CONSUMPTION
FOR
FY75 THRU FY80
FORT PICKETT & RESERVE CENTERS
FIGURE 5

KEY
 — FUEL OIL & KEROSENE
 - - - - - ELECTRICITY
 — — — — — LP & NATURAL GAS



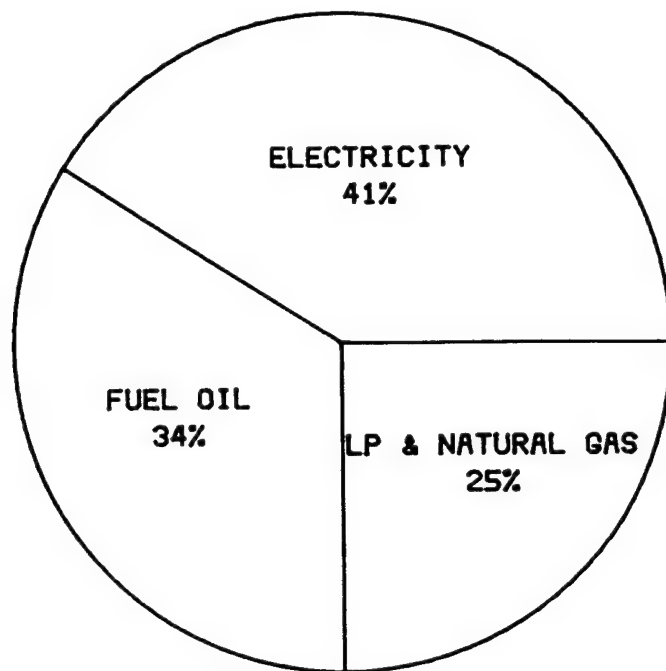
**TOTAL ENERGY USE
FY 1980
FORT PICKETT & RESERVE CENTERS
155,348 MBTU PER YEAR**

FIGURE 6A



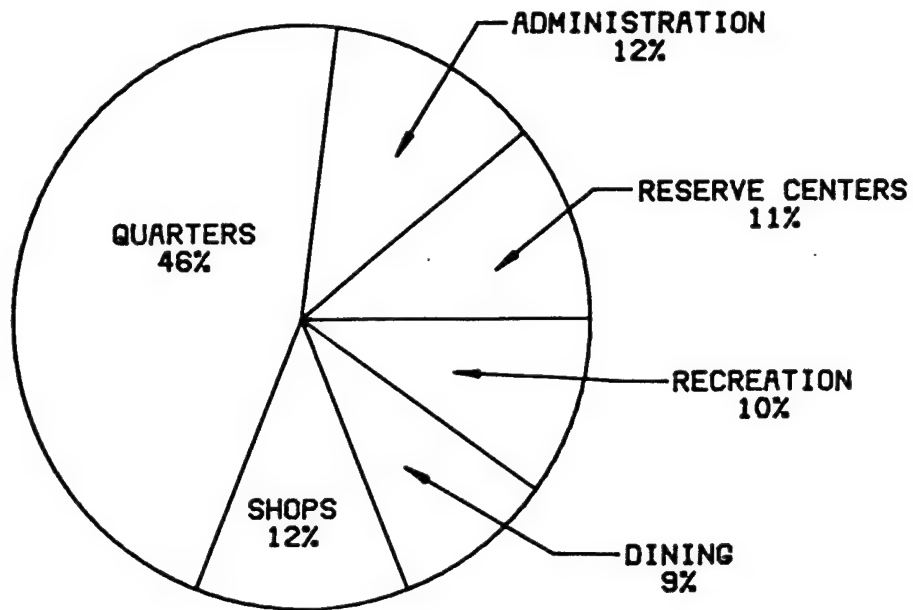
TOTAL ENERGY USE
FY 1980
FORT PICKETT
139,366 MBTU PER YEAR

FIGURE 6B



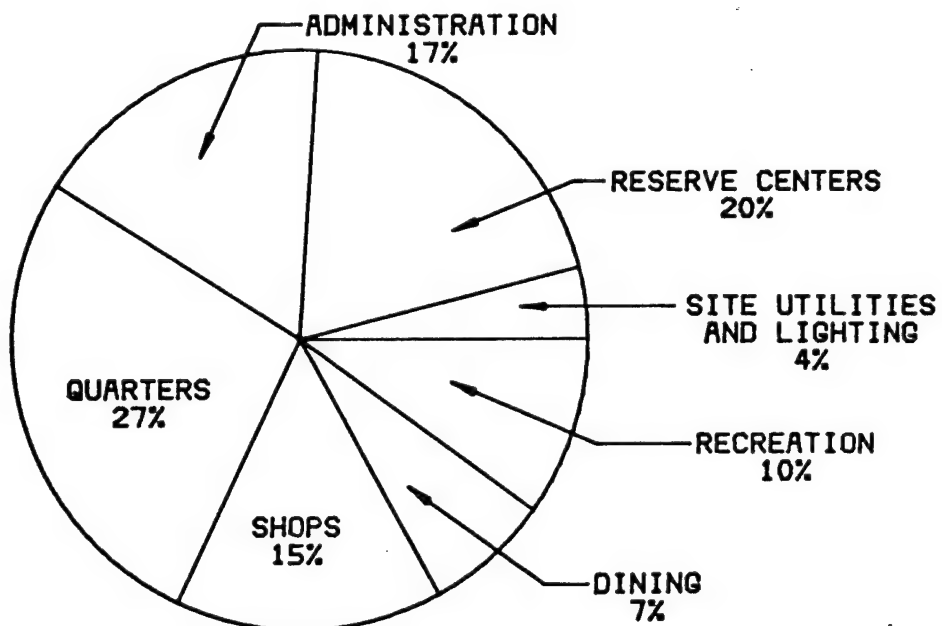
TOTAL ENERGY USE
FY 1980
RESERVE CENTERS
15,982 MBTU PER YEAR

FIGURE 6C



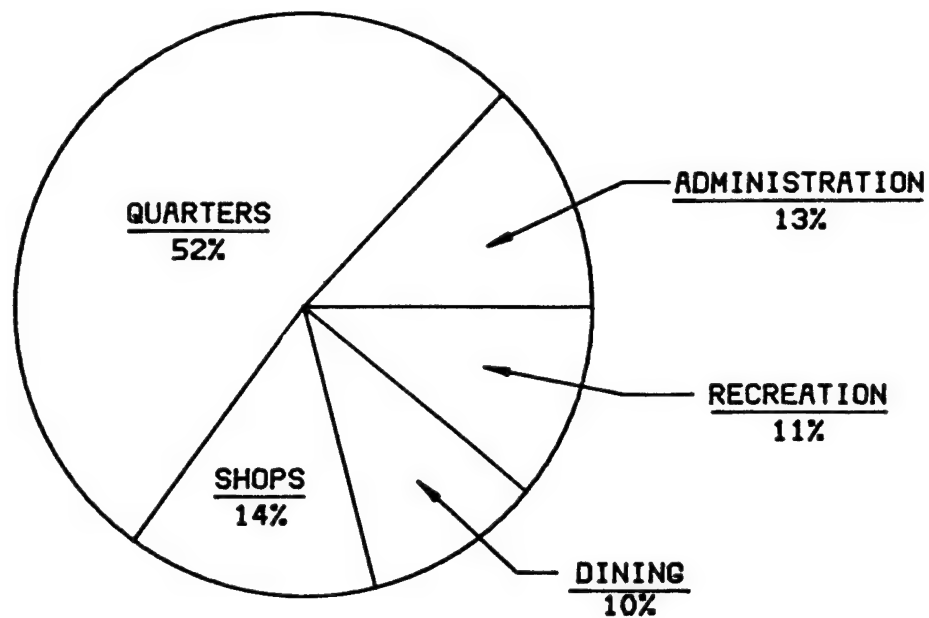
FT. PICKETT & RESERVE CENTERS BLDG. USE GROUP AREA

TOTAL BUILDING AREA = 2,354,442 SQ. FT.



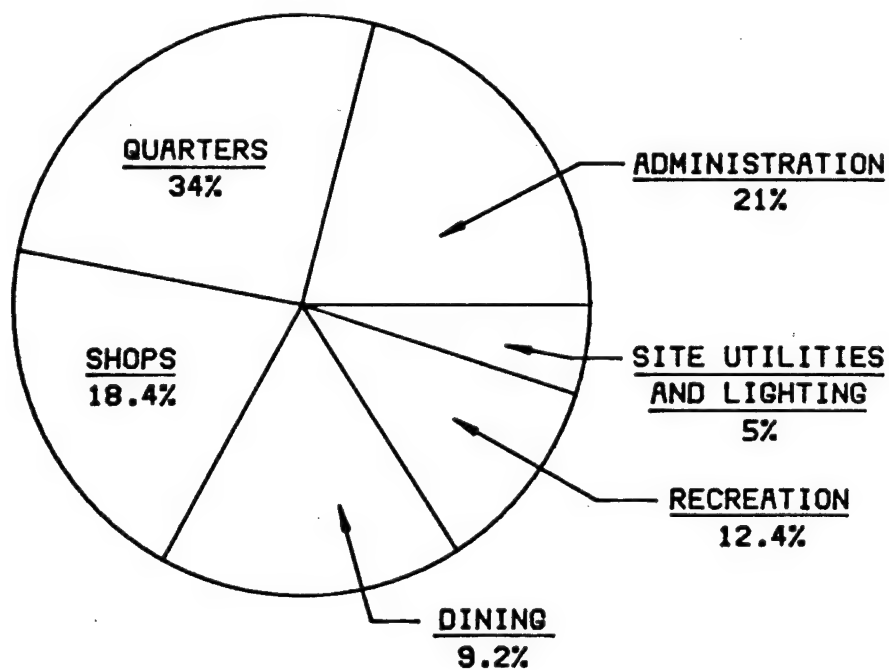
FT. PICKETT & RESERVE CENTERS BLDG. GROUP ENERGY USE

TOTAL ENERGY USE = 168,949 MILLION BTU



FORT PICKETT BLDG. USE GROUP AREA

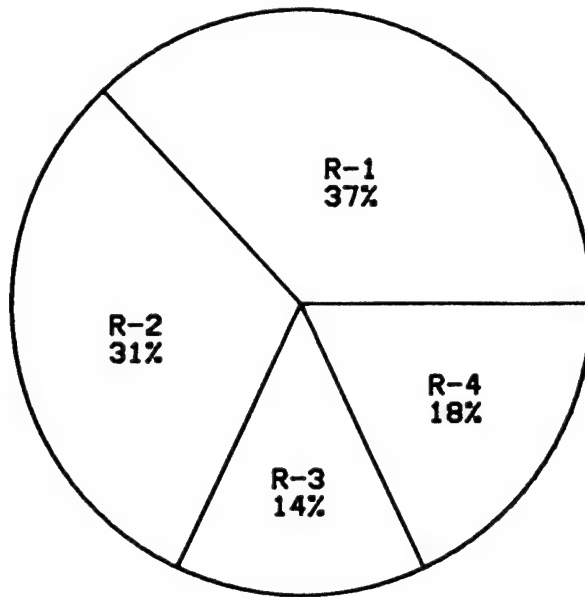
TOTAL BUILDING AREA = 2,103,063 SQ. FT.



FORT PICKETT BLDG. GROUP ENERGY USE

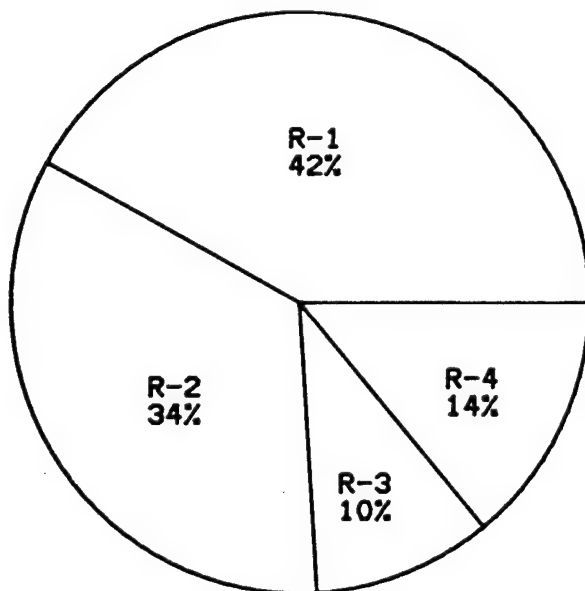
TOTAL ENERGY USE = 134,437 MILLION BTU

FIGURE 7B



**RESERVE CENTERS
BLDG. USE GROUP AREA**

TOTAL BUILDING AREA = 251,379 SQ. FT.



**RESERVE CENTERS
BLDG. GROUP ENERGY USE**

TOTAL ENERGY USE = 34,512 MILLION BTU

FIGURE 7C

FORT PICKETT

ENERGY ENGINEERING ANALYSIS PROGRAM
CONTRACT NO. DACA65-81-C-0021

LEGEND:

- X = GOOD OPTION
- Y = FEASIBLE OPTION
(TO RECEIVE PRELIMINARY STUDY)
- Z = POOR OPTION
(SEE COMMENTS)
- O = NOT APPLICABLE
- = USE GROUP BLDGS. (AGGREGATE AREA)
WITHOUT ENERGIZED HEATING SYSTEMS

A. ENVELOPE

| BUILDING USE GROUP | SUB-GROUP | STUDY BLDG. | EXTERIOR VESTIBULES | INTERIOR VESTIBULES | STORM WINDOWS | WEATHERSTRIPPING & CAULKING | CEILING INSULATION | HALL INSULATION | FLOOR INSULATION | REDUCTION OF WINDOW GLAZING | TROMBE HALL ADAPTATION | OVERHEAD DOOR REPLACEMENT | DROPPED CEILING | DOMESTIC HOT WATER | WATER HEATER TIME CLOCK | HW CIRC. PUMP CONTROLS | INSULATE DHW PIPING | INSULATE DHW HEATER | SHOWER / LAV. FLOW RESTRICTORS |
|-----------------------|-----------|-----------------|---------------------|---------------------|---------------|-----------------------------|--------------------|-----------------|------------------|-----------------------------|------------------------|---------------------------|-----------------|--------------------|-------------------------|------------------------|---------------------|---------------------|--------------------------------|
| ADMINISTRATION | A-1 | 471 | Z | Y | O | X | Y | Y | Y | O | O | O | O | | Z | O | X | O | Z |
| | | 472 | Z | Y | O | X | Y | Y | Y | O | O | O | O | | X | O | X | O | Z |
| | | 473 | Z | Y | O | X | Y | Y | Y | O | O | O | O | | X | O | X | O | Z |
| | | 2010 | Z | O | X | X | Z | X | O | O | O | O | O | | X | Y | X | O | Z |
| QUARTERS | A-3 | ■ | O | O | O | O | O | O | O | O | O | O | O | | O | O | O | O | O |
| | B-1 | 467 | Z | O | Z | X | Z | Z | O | O | O | O | O | | Z | O | O | O | X |
| | | 2442 | Z | O | X | X | X | X | X | O | O | O | O | | Z | O | Z | Z | O |
| SHOPS | B-2 | ■ | O | O | O | O | O | O | O | O | O | O | O | | O | O | O | O | O |
| | C-1 | 318 | Z | O | O | X | Y | Y | O | Y | O | X | Y | | X | O | O | X | Z |
| | | 564 | Z | O | O | X | Y | Y | O | O | O | X | Y | | X | O | O | X | Z |
| DINING | C-2 | ■ | O | O | O | O | O | O | O | O | O | O | O | | O | O | O | O | O |
| | | 467 | Y | O | Z | O | Z | Z | O | O | O | O | O | | Z | O | O | O | Z |
| | | 2101 | Y | O | O | X | Y | Y | Y | Y | O | O | O | | X | O | X | X | Z |
| WAREHOUSE | D-1 | 2440 | Z | O | X | X | X | X | X | O | O | O | O | | Z | O | Z | Y | O |
| | | ■ | O | O | O | O | O | O | O | O | O | O | O | | O | O | O | O | O |
| | | 1613 | Y | O | X | X | Z | Y | O | Y | O | O | O | | Z | O | O | X | X |
| RECREATION | F-1 | ■ | O | O | O | O | O | O | O | O | O | O | O | | O | O | O | O | O |
| | F-2 | ■ | O | O | O | O | O | O | O | O | O | O | O | | O | O | O | O | O |
| | | ■ | O | O | O | O | O | O | O | O | O | O | O | | O | O | O | O | O |
| RESERVE CENTERS | R-1 | MICHELLY | O | Z | X | X | Y | X | O | Y | Y | X | O | | O | O | O | O | O |
| | | MONTEITH | O | Z | X | X | Y | X | O | Y | Y | X | O | | O | O | O | O | O |
| | | HALL | O | Z | X | X | Y | X | O | Y | Y | X | O | | X | X | X | X | O |
| | R-2 | DUBLIN | O | Z | Y | Y | Z | Z | O | Z | Z | Z | O | | Z | O | Z | Y | O |
| | R-3 | CHARLOTTESVILLE | O | Z | Y | Y | Z | Z | O | Z | Z | Z | O | | Z | O | Z | Y | O |
| | R-4 | COVINGTON | O | Z | Y | X | Z | Z | O | Z | Z | Z | O | | Z | O | Z | Y | O |
| | | | O | Z | Y | X | Z | Z | O | Z | Z | Z | O | | Z | O | Z | Y | O |
| SITE UTILITIES & LTG. | | | O | O | O | O | O | O | O | O | O | O | O | | O | Y | O | O | O |

PRELIMINARY MATRIX - ENERGY C

| E | B. MECHANICAL | | | | | | | | | | | | | | | | | | | | C. ELECTRICAL | | | | | | | | | | | | | | | |
|---|------------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|---------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| | DROPPED CEILING | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | DOMESTIC HOT WATER | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | WATER HEATER TIME CLOCK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | HW CIRC. PUMP CONTROLS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | INSULATE DHW PIPING | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | INSULATE DHW HEATER | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | SHOWER / LAV. FLOW RESTRICTORS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | HVAC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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EEA PROJECT SUMMARY

| INC. | PROJECT | SIR | E/C RATIO | B/C RATIO | INSTALL. COST (#) | ANNUAL SAVINGS (MBTU) | PAYBACK (YRS.) |
|------|---|------|-----------|-----------|-------------------|-----------------------|----------------|
| A | WATER HEATER INSULATION | 42.9 | 160.8 | 54.9 | 31,477 | 5,060 | 0.4 |
| A | BURNER REPLACEMENT | 29.7 | 107.0 | 37.9 | 2,834 | 303 | 0.6 |
| A | CEILING FANS | 11.8 | 38.5 | 15.0 | 48,549 | 1,870 | 1.6 |
| A | NIGHT SETBACK (FORT PICKETT) | 3.6 | 25.7 | 4.3 | 220,841 | 5,679 | 3.4 |
| A | REPLACEMENT OF INEFFICIENT LIGHT FIXTURES | 1.6 | 14.3 | 1.8 | 138,325 | 1,989 | 9.2 |
| B | EMCS | 1.7 | 13.2 | 2.2 | 677,334 | 8,916 | 7.5 |
| A | WALL INSULATION | 2.9 | 12.4 | 3.7 | 126,099 | 1,557 | 6.2 |
| A | CEILING INSULATION (FORT PICKETT) | 2.7 | 9.7 | 3.4 | 356,887 | 3,479 | 7.0 |
| A | BOILER REPLACEMENT | 1.9 | 6.8 | 24.1 | 230,757 | 1,571 | 1.0 |
| A | NIGHT SETBACK (RESERVE CENTERS) | 23.6 | 162.1 | 26.9 | 7,489 | 1,241 | 0.6 |
| A | MINIMUM OCCUPANCY HTG/CLG UNITS (RESERVE CENTERS) | 1.8 | 12.4 | 2.1 | 12,953 | 160 | 7.0 |
| A | WEATHERSTRIPPING & CAULKING (RES. CTRS.) | 4.5 | 18.8 | 6.2 | 14,556 | 273 | 4.3 |
| A | CEILING INSULATION (RESERVE CENTERS) | 23.2 | 90.4 | 30.8 | 28,695 | 2,594 | 0.8 |
| | TOTAL: | - | - | - | 1,897,796 | 34,692 | - |

FIGURE 9

EEA PROJECT SUMMARY

| INCREMENT | PROJECT | E/C RATIO | B/C RATIO | INSTALL. COST (#) | ANNUAL SAVINGS (MBTU) | PAYBACK (YRS.) |
|-----------|--|-----------|-----------|-------------------------|--------------------------|-------------------|
| 0 X | WEATHERSTRIP & CAULK | 8.9 | 3.1 | 38,566 | 352 | 8.1 |
| 0 X | STORM WINDOWS | 4.9 | 1.7 | 226,330 | 1,104 | 15.0 |
| 0 | WATER HEATER CONTROLS | 1.3 | 0.1 | 278 | 0.4 | 98.6 |
| 0 | TIMER SWITCHES | 19.9 | 0.7 | 49,031 | 975 | 6.4 |
| 0 X | CMU WALL INSULATION (RESERVE CENTERS) | 5.9 | 2.0 | 182,543 | 1,133 | 12.8 |
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FIGURE 10

EEA PROJECT SUMMARY

[illegible]■ PER 100 FT² OF COLLECTOR AREA

FIGURE 11

EEA PROJECT SUMMARY

| INCREMENT | PROJECT | E/C RATIO | B/C RATIO | INSTALL. COST (\$) | ANNUAL SAVINGS (MBTU) | PAYBACK (YRS.) |
|-----------|---|-----------|-----------|--------------------------|--------------------------|-------------------|
| F | WATER HEATER CONTROLS (RESERVE CENTERS) | 43.5 | 5.1 | 3,321 | 145 | 2.7 |
| F | REPLACE INEFFICIENT LIGHT FIXTURES (RESERVE CENTERS) | 10.3 | 1.4 | 4,082 | 42 | 9.5 |
| F | REPLACE INEFFICIENT SITE LIGHTING (RESERVE CENTERS) | 20.6 | 3.6 | 1,625 | 34 | 4.0 |
| F | REPLACE STANDARD FLUORESCENT LAMPS (FORT PICKETT) | 36.6 | 7.4 | 17,206 | 629 | 3.5 |
| | | | | | | |
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| | TOTAL: | | | 64,401 | 3,225 | |

NOTE: ANNUAL MBTU SAVINGS MARKED THUS () WERE CALCULATED ON A "PER UNIT" BASIS AND COULD NOT BE QUANTIFIED WITH TOTAL SAVINGS.

FIGURE 12

EEA PROJECT SUMMARY

| INCREMENT | PROJECT | E/C RATIO | B/C RATIO | INSTALL. COST (\$) | ANNUAL SAVINGS (MBTU) | PAYBACK (YRS.) |
|-----------|--|-----------|-----------|--------------------------|--------------------------|-------------------|
| F | PHOTOCELL & TIME CLOCK LIGHTING CONTROLS | 113.0 | 8.4 | 636 | 72 | 1.1 |
| F | REPLACE STANDARD FLUORESCENT LAMPS (FORT PICKETT) | 89.6 | 4.1 | 19,689 | 1,765 | 1.5 |
| F | REDUCE LIGHTING LEVELS TO MINIMUM STANDARDS | 62.0 | 8.0 | 8,638 | 538 | 2.2 |
| F | HIGH EFFICIENCY-TYPE MOTORS | 23.3 | 1.3 | 637 | (14) | 5.5 |
| F | DOMESTIC HOT WATER CIRCULATING PUMP CONTROL | 43.4 | 4.8 | 219 | (10) | (2.2) |
| F | INSULATED DAMPER PANELS | 30.9 | 9.2 | 76 | (2) | 3.7 |
| F | ELIMINATION OF DOMESTIC HOT WATER | 3267.1 | 564.8 | 15 | (48) | 0.1 |
| F | REDUCTION OF WINDOW GLAZING | 79.1 | 28.8 | 20 | (2) | 0.9 |
| F | REPLACEMENT OF OVERHEAD DOORS | 37.4 | 14.0 | 3263 | (122) | 1.8 |
| F | CORRECT POWER FACTOR | - | - | 6,586 | - | 18.0 |
| F | FUTURE METERING PLAN | - | - | 1,982 | - | - |
| | | | | | | |

NOTE: ANNUAL MBTU SAVINGS MARKED THUS () WERE CALCULATED
ON A "PER UNIT" BASIS AND COULD NOT BE QUANTIFIED
WITH TOTAL SAVINGS.

FIGURE 12 (CONT.)

| ESCALATED ACTUAL FUEL COST (\$/MBTU) | | | | | | |
|--------------------------------------|-------------|------|------|-------|-------|-------|
| FUEL # | FISCAL YEAR | | | | | |
| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
| ELECTRICITY | 4.31 | 4.48 | 5.15 | 5.93 | 6.81 | 7.84 |
| #2 FUEL OIL | 7.02 | 8.54 | 9.83 | 11.30 | 12.99 | 14.94 |
| NATURAL GAS | 4.17 | 5.06 | 6.07 | 7.29 | 8.74 | 10.49 |

ENERGY COST PROJECTION

■ ESCALATED AS RECOMMENDED BY CORPS OF ENGINEERS "ENERGY CONSERVATION INVESTMENT PROGRAM GUIDANCE" APPENDIX B, TABLE 2.

FIGURE 13

ENERGY PROJECTION SUMMARY

| ITEM | MBTU | PERCENT CHANGE |
|---|------------|----------------|
| FY 1975 TOTAL ENERGY CONSUMPTION | 168,949 | - |
| A. PAST ENERGY CONSERVATION PROJECTS | (-) 7,623 | (-) 4.5% |
| B. ENERGY CONSERVATION PROJECTS UNDER CONTRACT | (-) 4,898 | (-) 3.9% |
| C. EXISTING OPERATIONAL & MAINTENANCE PROCEDURES | (+) 19,398 | (+) 11.5% |
| D. DEMOLITION AND SHUTDOWN | (-) 276 | (-) 0.1% |
| E. NEW CONSTRUCTION PROJECTS | (+) 10,729 | (+) 6.4% |
| F. RECOMMENDED ENERGY PROJECTS: INCREMENTS (A), (B) & (F) | (-) 37,917 | (-) 22.4% |
| FY 1985 ENERGY CONSUMPTION PROJECTION | 148,362 | (-) 13.0% |

NOTES:

1. ENERGY SAVINGS RESULTING FROM SOME INCREMENT (F) PROJECTS COULD NOT BE PROJECTED, SEE FIGURE 3-7.

2. (-) INDICATES A REDUCTION IN ENERGY USE, (+) INDICATES AN INCREASE IN ENERGY USE.

3. SEE SECTION 3.4 OF THE REPORT NARRATIVE FOR FURTHER DESCRIPTION OF O&M PROCEDURES.

4. TOTAL MBTU QUANTITIES IN THIS FIGURE REFLECT THE COMBINATION FORT PICKETT & RESERVE CENTER TOTALS.

FIGURE 14